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(56) Documents Cited
GB 1218915 A GB 0960498 A GB 0606058 A
EP 0397872 A US 4693328 A

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(54) Reamer with radially adjustable rollers

(57) A reamer device 1 for reaming the sides of a borehole comprises, a housing 2 adapted to be connected to and rotated with a drilling apparatus, a plurality of mountings 4,5 provided on the housing, and arranged circumferentially thereof for receiving respective rollers 11, and adjustment means connected to the mountings, for adjusting the radial distance between the rollers 11 and longitudinal axis 3 of the housing 2, to enable the rollers 11 to move into and out of engagement with the sides of the borehole. As shown the adjustment means comprise an inner mandrel 18 having an inclined exterior surface 29, which contacts a contrasting inclined interior surface 30 on the roller mountings 4,5. Axial movement of the mandrel 18, which can be actuated by differential pressure, transposes via the inclined surfaces 29,30, to radial movement of the mountings 4,5 and thus the rollers 11. A compression spring 22 can be used to disengage the rollers 11, when said pressure is released.

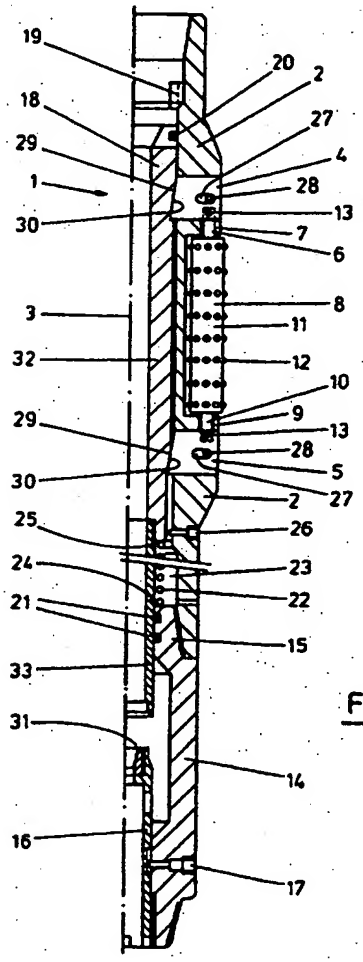

FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

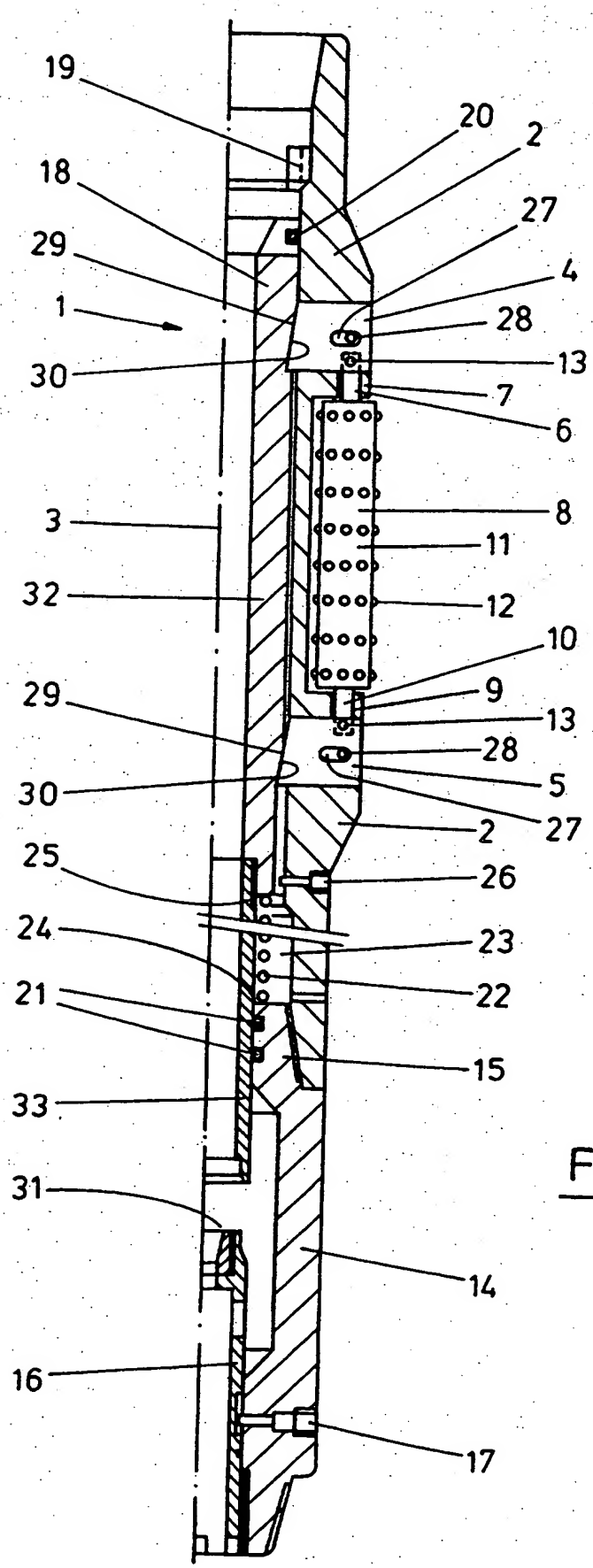
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FIG. 1

ADJUSTABLE ROLLER REAMER

The present invention relates to an adjustable roller reamer for attachment to downhole drilling apparatus, and relates particularly, but not exclusively, to such a roller reamer for use in the oil and gas industry.

Roller reamers are used in the oil and gas industry when drilling in order to ream a well bore to ensure that it is at least the same size diameter of the drill bits being used. Roller reamers are also useful when drilling through hard or swelling rock formations.

Known roller reamers generally comprise an elongate body portion which can be attached to a drill string inserted in a well, and a plurality of reamer rollers arranged circumferentially of the body portion such that the outer most part of each reamer roller projects laterally beyond the outer most part of the body portion. The reamer rollers are generally in the form of elongate cylinders of hard material and having projections on their outer circumferences, such that when the reamer is rotated with a drill bit, the reamer rollers come into contact with and ream the walls of the well.

The known roller reamers have a number of significant drawbacks. Firstly, once the rollers are mounted to the body portion, the external diameter of the roller reamer is generally constant and cannot be adjusted downhole, other than through wear of the reamer rollers, which reduces the effectiveness of the reamer. Because the external diameter of the roller reamer remains generally constant, it is often very difficult to remove the drilling tools from a well which is very similar in internal diameter to the external diameter of the roller reamer.

It is therefore an object of the present invention to overcome the above disadvantages of the prior art.

According to an aspect of the present invention, there is provided a reamer device for reaming the sides of a borehole, the device comprising a housing adapted to be connected to and rotated with a drilling apparatus passed in use down the borehole, a plurality of mountings provided on the housing and arranged circumferentially thereof for receiving respective

rollers, and adjustment means connected to the mountings for adjusting the radial distance between the rollers and the longitudinal axis of the housing in use to enable the reamer rollers to move into and out of engagement with the sides of the borehole.

The present invention therefore has the advantage that the outer diameter of the roller reamer is adjustable and can therefore not only be adjusted to suit the borehole diameter, but can also be reduced to facilitate removal from the borehole of a drill string to which the reamer is attached.

In a preferred embodiment, the device further comprises an axial member arranged within the housing and axially movable relative thereto, and co-operating means acting between the axial member and the mountings wherein axial movement in use of the axial member relative to the housing adjusts the radial separation between the rollers and the longitudinal axis of the housing.

By providing an axial member slidable relative to the housing, the device can be adapted to be attached to conventional drilling bits and operated by suitable means known to persons skilled in the art, such as a pressure differential along the length of the body portion, or the application of weight to the axial member.

The co-operating means preferably comprises mutually engaging pairs of inclined surfaces provided on the axial member and respective mountings.

In this way, the co-operating means can operate in a simple manner and with the minimum number of moving parts, which therefore reduces the tendency of the device to mal function or jam as a result of dirt and / or mud.

The device is preferably adapted to be operated by means of a pressure difference between upper and lower parts of the axial member, wherein downward movement in use of the axial member relative to the housing causes outward movement of the reamer rollers.

Alternatively, the device may be adapted to be operated such that application of weight in use to the axial member

causes downward movement thereof relative to the housing to cause outward movement of the rollers, and said downward movement is released by means of a weight sensitive tool.

The device preferably further comprises urging means acting between the axial member and the housing to release the adjustment means.

This has the advantage of assisting in disengaging the rollers from the borehole walls in use, to facilitate removal of the drill string to which the reamer is attached from the borehole.

The urging means may comprise a compression spring arranged between the axial member and the housing.

According to another aspect of the invention, there is provided a roller reamer comprising a reamer device as defined above and respective rollers mounted to said mountings.

In this way, each roller can be separately replaced such that the maximum amount of use can be obtained from each roller before wearing reduces its effectiveness.

In order that the invention may be better understood, a preferred embodiment is described in detail below, by way of example only and not in any limitative sense, with reference to the accompanying drawing, in which:

Figure 1 shows a partial cross-sectional view of a roller reamer embodying the present invention.

Referring in detail to Figure 1, there is shown in partial longitudinal cross-section the right-hand half of an adjustable roller reamer 1 embodying the present invention. The roller reamer 1 comprises an elongate main body 2 of generally circular transverse cross-section and having a longitudinal axis 3. The main body 2 is fitted with mountings (of which only one is shown in Figure 1) in the form of pairs of upper 4 and lower 5 roller blocks, such that each pair of upper 4 and lower 5 roller blocks is radially slidable relative to the main body 2.

Each of the upper roller blocks 4 has a recess 6 in its lower surface for receiving an upper roller pin 7 of a corresponding roller 8 of which only one is shown in Figure 1.

Similarly, each of the lower roller blocks 5 has a recess 9 in its upper surface for receiving a lower roller pin 10 of the respective roller 8 such that each roller 8 can be mounted between each pair of upper 4 and lower 5 roller blocks so as to be generally radially movable relative to the longitudinal axis 3 of the reamer 1. The upper 7 and lower 9 roller pins are provided with retainer pins 13 to limit rotation of the rollers 8 relative to the main body 2.

Each roller 8, one of which is shown in perspective in Figure 1, has a generally cylindrical body portion 11 and a plurality of projections 12 projecting outwardly from the body portion. The projections 12 of the roller 8 shown in Figure 1 are arranged in generally equiangularly spaced axially extending rows, although it will be appreciated by persons skilled in the art that any suitable arrangement of projections 12 could be used. The rollers 8 are mounted via pins 7, 10 to the roller blocks 4, 5 such that the circumference of each roller 8 projects slightly beyond the radially outer most surface of the main body 2.

A bottom sub-portion 14 has a tapered upper portion 15 which is attached to the bottom part of the main body 2. The bottom sub-portion 14 is co-axial with the main body 2, and is provided with a stopper sleeve 16 attached thereto by means of a set screw 17.

A hollow mandrel 18 of generally circular cross-section is arranged co-axially with the main body 2 and is axially slidable relative thereto between an upper position in which it abuts against a retainer ring 19 provided is the bore of the main body 2 and a lower position at which it abuts the upper part 31 of the stopper sleeve 16. The hollow mandrel 18 comprises an upper part 32 having an external diameter slightly less than the internal diameter of the adjacent part of the main body, and a lower part 33 having an external diameter slightly less than the internal diameter of the adjacent part of the bottom sub 14.

A mandrel seal 20 is provided between the upper part 32 of the mandrel 18 and the internal surface of the upper part of

the main body 2, and a pair of bottom sub-seals 21 are provided between the lower part 33 of the mandrel 18 and the internal surface of upper portion 15 of the bottom sub-portion 14, such that an annular chamber 22 is defined between seals 20, 21. A compressive return spring 23 is arranged in the annular chamber 22 and acts between upper surface 24 of upper portion 15 of bottom sub 14 and end face 25 of the upper part 32 of mandrel 18, such that downward movement of the mandrel 18 relative to the main body 2 is opposed by the return spring 23. A guide pin 26 passing through the main body 2 aligns the mandrel 18 relative to the main body 2.

The upper 4 and lower 5 roller blocks are provided with laterally extending slots 27 in which block retainer pins 28 provided on the main body 2 are accommodated, so as to limit radial movement of the blocks 4, 5 relative to longitudinal axis 3. The roller blocks 4, 5 are provided on their radially inward surfaces with inclined surfaces 29 which engage corresponding inclined surfaces 30 provided on the external circumference of the upper part 32 of mandrel 18.

The operation of the reamer 1 shown in Figure 1 will now be described in detail.

When the reamer 1 is incorporated into a drill string and inserted into the borehole, the hollow mandrel 18 is in its upper position in which return spring 23 urges it upwards into abutment with retainer ring 19. At this time, the rollers 8 are not urged outwards relative to the longitudinal axis 3, and so the reamer 1 has its minimum diameter.

When drilling commences, rig pumps (not shown, but which will be well-known to persons skilled in the art) create a pressure differential in a manner which will be well-known to persons skilled in the art and therefore not described in greater detail herein, which in turn causes downward movement of the mandrel 18 relative to the main body 2.

As the mandrel 18 moves downwards, its inclined surfaces 30 slide against corresponding inclined surfaces 29 of the roller blocks 4, 5 thus causing the rollers 8 to move radially outwards. As a result, the diameter of the reamer 1 increases

to improve the reaming / hole opening effect of the reamer 1. Downward movement of the mandrel 18 can take place until the lower extremity of lower part 33 of the mandrel abuts against upper part 31 of stopper sleeve 16, which corresponds to the maximum diameter of the reamer 1.

When drilling is complete, the pumps (not shown) are turned off, as a result of which return spring 23 urges hollow mandrel 18 upwards to release the outward urging force on rollers 8. As a result, rollers 8 and corresponding roller blocks 4, 5 can be moved radially inwards to reduce the diameter of the reamer, which in turn reduces hole drag and sticking problems as the drill string is removed from the borehole.

It will be understood by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various modifications of the invention are possible without departure from the scope of the appended claims. In particular, although the embodiment of Figure 1 has been described in terms of a mandrel 18 axially movable by means of a pressure differential, it will be understood by persons skilled in the art that downward axial movement of mandrel 18 could be caused by the addition of weight thereto in a manner well-known to persons skilled in the art, with re-setting of the mandrel 18 being achieved by means of a weight-sensitive tool.

CLAIMS:

1. A reamer device for reaming the sides of a borehole, the device comprising a housing adapted to be connected to and rotated with a drilling apparatus passed in use down the borehole, a plurality of mountings provided on the housing and arranged circumferentially thereof for receiving respective rollers, and adjustment means connected to the mountings for adjusting the radial distance between the rollers and the longitudinal axis of the housing in use to enable the rollers to move into and out of engagement of the sides of the borehole.

2. A device according to claim 1, further comprising an axial member arranged within the housing and axially movable relative thereto, and co-operating means acting between the axial member and the mountings wherein axial movement in use of the axial member relative to the housing adjusts the radial separation between the rollers and the longitudinal axis of the housing.

3. A device according to claim 2, wherein the co-operating means comprises mutually engaging pairs of inclined surfaces provided on the axial member and respective mountings.

4. A device according to claim 2 or 3, wherein the device is adapted to be operated by means of a pressure difference between upper and lower parts of the axial member, wherein downward movement in use of the axial member relative to the housing causes outward movement of the rollers.

5. A device according to claim 2 or 3, wherein the device is adapted to be operated such that application of weight in use to the axial member causes downward movement thereof relative to the housing to cause outward movement of the rollers, and said downward movement is released by means of a weight-sensitive tool.

6. A device according to any one of claims 2 to 5, further comprising urging means acting between the axial member and the housing to release the adjustment means.

7. A device according to claim 6, wherein the urging means comprises a compression spring arranged between the axial

member and the housing.

8. A roller reamer comprising a reamer device according to any one of the preceding claims and respective rollers mounted to said mountings.

9. A roller reamer substantially as hereinbefore described with reference to the accompanying drawings.

Application No: GB 9611807.0 **Examiner:** Richard Jupp
Claims searched: 1-9 **Date of search:** 8 September 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): E1F: FCJ

Int Cl (Ed.6): E21B

Other: Online: World Patents Index

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1218915 A	(ROTARY OIL TOOL COMPANY) whole document relevant	1-6,8
X	GB 0960498 A	(SODING & HALBACH) whole document relevant	1,8
A	GB 0606058 A	(GRANT OIL TOOL COMPANY) whole document relevant	
X	EP 0397872 A1	(TATARSKY GOSUDARTVENNY) whole document relevant	1-6,8
X	US 4693328 A	(SMITH INTERNATIONAL INC.) see especially col.4 lines 63-68	1,2,8

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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E Patent document published on or after, but with priority date earlier than, the filing date of this application.